Clouds and the Earth's Radiant Energy System (CERES)

Data Management System

Requirements Management Plan

Version 3

Primary Author(s)

Walter F. Miller and John L. Robbins

Science Applications International Corporation (SAIC)
One Enterprise Parkway, Suite 300
Hampton, VA 23666

NASA Langley Research Center
Climate Science Branch
Science Directorate
21 Langley Boulevard
Hampton, VA 23681-2199

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Document Revision Record

The Document Revision Record contains information pertaining to approved document changes. The table lists the Version Number, the date of the last revision, a short description of the revision, and the revised sections. The document authors are listed on the cover.

Document Revision Record

Version Number	Date	Description of Revision	Section(s) Affected
V1	10/11/2005	• Initial version of CERES Requirements Management Plan. • Updated format to comply with standards.	All All
V2	04/15/2006	• Updated Introduction and added References and Appendix A to conform to new plan standards. • Added information on stakeholders. • Tables to describe understanding requirements, bidirectional traceability. and identify inconsistencies were added. Changes were made to other tables. • Updated format to comply with standards.	Section 1, References, and App. A Section 1 Section 2 All
V3	09/05/2006	• Incorporated changes from July 17, 2006 Peer Review. The minutes from the Peer Review are the official record of changes. • Table of Contents and List of Figures were updated and "s" added to "requirement." • Updated format to comply with standards.	All TOC and LOF All

Preface

The CERES DMS supports the data processing needs of the CERES Science Team research to increase understanding of the Earth's climate and radiant environment. The CERES Data Management Team works with the CERES Science Team to develop the software necessary to support the science algorithms. This software, being developed to operate at the Langley ASDC, produces an extensive set of science data products. The DMS consists of 12 subsystems; each subsystem contains one or more PGEs.

This plan's purpose is to provide specific guidance on the Requirements Management process in receiving, accepting, and implementing requirements for the development of CERES DM software that will be delivered to the Langley ASDC. The CERES SDP provides specific guidance and definition of the Software Development Process used by the CERES DMT. The CERES DMP provides overall guidance to the CERES DMT.

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1.0 Introduction

CERES is a key component of EOS. The CERES instrument provides radiometric measurements of the Earth's atmosphere from three broadband channels: a shortwave channel (0.3 - 5 μm), a total channel (0.3 - 200 μm), and an infrared window channel (8 - 12 μm). The CERES instruments are improved models of the ERBE scanner instruments, which operated from 1984 through 1990 on NASA ERBS and on NOAA operational weather satellites NOAA-9 and NOAA-10. The strategy of flying instruments on Sun-synchronous, polar orbiting satellites, such as NOAA-9 and NOAA-10, simultaneously with instruments on satellites that have precessing orbits in lower inclinations, such as ERBS, was successfully developed in ERBE to reduce time sampling errors. CERES continues that strategy by flying instruments on the polar orbiting EOS platforms simultaneously with an instrument on the TRMM spacecraft, which has an orbital inclination of 35 degrees. In addition, to reduce the uncertainty in data interpretation and to improve the consistency between the cloud parameters and the radiation fields, CERES includes cloud imager data and other atmospheric parameters. The CERES instruments fly on the TRMM spacecraft and on the EOS Terra and Aqua platforms. The TRMM satellite carries one CERES instrument while the EOS satellites carry two CERES instruments, one operating in a fixed azimuth scanning mode and the other operating in a rotating azimuth scanning mode.

The CERES DMT is responsible for the development and maintenance of the software used to process the data received from the on-orbit CERES instruments. For the purposes of this document, product refers to the CERES software delivered to the ASDC and is not to be confused with CERES data products, which are created by the CERES software.

The CERES project management and implementation responsibility is at NASA LaRC. The CERES Science Team is responsible for the instrument design and the derivation and validation of the scientific algorithms used to produce the data products distributed to the atmospheric sciences community. The CERES DMT is responsible for the development and maintenance of the software that implements the science team's algorithms used in the production environment. The Langley ASDC is responsible for the production environment, archival and distribution of the CERES data products generated at NASA Langley.

The purpose of the CERES Requirements Management Plan is to provide specific guidance on the Requirements Management process in receiving, accepting, and implementing requirements for the development of CERES DM software that will be delivered to the Langley ASDC.

This document is organized as follows:

1.1 CERES Program Plan

All current software requirements must be traceable back to and within the scope of the Statement of Work as found in the CERES and ERBE Data Management System Support Program Plan. (See Reference 1). The CERES and ERBE Data Management System Support Program Plan is updated annually. The SOW from the Program Plan follows.

> **Statement of Work**
> Provide coordination of contractor data management effort. Provide processing codes for implementing ERBE and CERES algorithms into Data Management Systems. The operational code must execute correctly at both the Science Computing Facilities and the Langley TRMM and Terra Information System (LATIS) at the Atmospheric Sciences Data Center. The support includes software design, development, implementation, testing, validation, configuration management, and documentation for processing and analyzing CERES and ERBE data from satellite missions. Provide validation processing for data products at the Science Computing Facilities as required. Documentation may include data products catalogs, interface requirements, data management plans, ancillary input data, quality assessment plans, coding guidelines, software design documents, validation documents, test plans, operator's manuals, data set collection guides, and other documentation as needed to satisfy project/program requirements. Provide system administration for CERES Science Computing Facility and related mission critical systems.

1.2 Algorithm Theoretical Basis Documents

The CERES Algorithm Theoretical Basis Documents (Reference 2) were written by the CERES Science Team WG to describe the scientific calculations to be implemented in the CERES DM software. From the ATBDs and other information provided by the DMT Lead a complete set (one for each CERES subsystem) of CERES Software Requirements Documents (Reference 3) were produced. The Software Requirements Documents served as a basis for the initial software design and guided the Release 1, the prelaunch version, subsystem development. Subsequent releases included updated algorithms and unique needs for each satellite.

1.3 Organization

The key organizational elements that are involved in the CERES software development are the CERES Science Team and the CERES DMT. The CERES Science Team consists of NASA personnel, NASA contractors, and personnel from other federal government organizations, educational institutes, foreign governments, and industry. The Science Team which consists of various WG is responsible for algorithms and CERES data product validation. The Science Team provides algorithm requirements or contributed code. The CERES DMT consists of NASA personnel and contractors and is responsible for the development of the operational CERES software which will be put in production at the ASDC. The NASA members of the DMT provide systems requirements regarding production environments, metadata, data product formats, and

input data. They transmit requirements needed to perform production at the ASDC. The assignment of responsibility for each task identified in Section2 of the Requirements Management Plan can be found in the CERES Requirement Responsibility Matrix shown in Table 1-1. Since science and system requirements flow from two different groups, the first task is broken into two for the matrix.

Table 1-1. CERES Requirement Responsibility Matrix

Task	Science Team	NASA DMT Manager	CERES Supervisor	Subsystem Team
Convey Science Requirements	P	S	S	S
Convey System Requirements	S	P	S	S
Obtain an Understanding of Require-ments	S	S	S	P
Accept Requirements	S	S	S	P
Obtain Commitment to Requirements	P	P	P	P
Manage Requirements Changes	S	S	P	P
Maintain Bidirectional Traceability of Requirements	S	S	S	P
Identify Inconsistencies between Project Work and Requirements	P	P	S	P

Key: P - Primary
     S - Secondary

2.0 CERES Requirements Management

The following tables describe the tasks associated with Requirements Management. demonstrate how requirements are conveyed and received by CERES DMT personnel, how understanding of the requirements is demonstrated, the acceptance criteria, and the feedback mechanism for confirming with the customer that the requirements have been received, understood, and the action that will be taken to implement the requirements.

Table 2-1. Convey Science and System Requirements

Conveyance Mechanism	Comments
Face-to-Face Meetings	Many of the CERES software requirements and changes to those requirements are conveyed to the software development teams though various meetings. The CERES Science Team Meetings and associated WG sessions are formally documented in the CERES Science Team Meeting Minutes (Reference 4) and (Reference 5). Regular biweekly meetings of the CERES DMT (minutes for these meetings are prepared by the DMT Lead (Reference 6). Occasionally, the CERES PI will hold "local" but more formal meetings with the WG chairs and DMT staff. Some WG chairs have periodic meetings with their team. Members of the DMT staff attend meetings with their WG chair or other members of the CERES Science Team. Requirements received through meetings without minutes are documented by return email or action item logs. All requirements are entered into the subsystem Requirements Log located on the CERES Requirements Log web site at http://asd-www.larc.nasa.gov/ceres/ requirements_logs/ (Reference 7) and a SCCR (Reference 8) is created if one does not exist.
Phone Calls	Phone calls are often made between Science Team or DMT members and members of the software development team, typically a subsystem lead to discuss requirements and their implementation. Requirements received by this method are documented by return email and entered into the subsystem Requirements Log located on the CERES Requirements Log web site and a SCCR is created if one does not exist.
Email	Requirements and changes to requirements also come by Emails can be received that contain new requirements or changes. This Email is the first level of documentation for the requirement. Requirements and changes to requirements that arrive by email are also entered into the subsystem Requirements Log located on the CERES Requirements Log web site and a SCCR is created if one does not exist.

Table 2-2. Obtain an Understanding of Requirements (1 of 2)

Evaluation Criteria	Comments
Clearly Stated	Emails, meeting minutes, and personal notes should be reviewed to ensure that all relevant information has been documented. Is the request unambiguous? Was it stated as a needed capability as opposed to a software solution?

Table 2-2. Obtain an Understanding of Requirements (2 of 2)

Evaluation Criteria	Comments
Complete	After having time to think about the requirement, determine if any questions are unanswered. Are other calculations or procedure impacted without knowing how they will change? Do you know exactly what will need to be changes?
Consistent	Does the new requirement contradict existing software requirements?
Implicit Assumptions	What implicit, not identified, requirements need to be implemented in conjunction with this requirement? Will a new data set be needed? Will additional error checking be required? Will the interface or data product change?
Appropriate	The requirement should be evaluated in terms of the overall and subsystem objectives. Is this subsystem the best place to implement the requirement?
Verifiable	A method to test the requirement should be determined. Does this process causes additional questions?
Questions	The requirement conveyor will be contacted to obtain answers to questions that were developed.
Restate	An email or document will be sent to the requirement conveyor stating the understanding of the requirement. Other stakeholders can be included on this email.

Table 2-3. Accept Requirements (1 of 2)

Acceptance Criteria	Comments
SOW	Proposed requirements or requirement changes must be within the scope of the SOW within the CERES and ERBE Data Management System Support Program Plan (see Reference 1).
Source	Software development requirements can be accepted only when received from one or more of the following and in accordance with the conveyance methods described in Table 2-1. a. the CERES Principal Investigator or a duly assigned representative, b. CERES Science Team WG Chairs or a duly assigned representative, c. the CERES DMT Lead or a duly assigned representative
Requirements Log	Top-Level requirements are entered into a Requirements Log that is maintained on the CERES Requirements Log Web site. New requirements or changes to requirements must be consistent with and traceable back to "parent" requirements in a Requirements Log. The procedure for updating a subsystem requirements log follows in Section 3.0.
Schedule	Proposed requirements or requirement changes must be consistent with CERES DP requirements as maintained by CERES CM in the current CM schedule which is available through the CERES CM Web site (Reference 8). The impact of proposed requirements or requirement changes that are NOT consistent with the DP schedule must be evaluated and the results of this evaluation must be provided to the conveyor of the requirement before it is accepted.

Table 2-3. Accept Requirements (2 of 2)

Acceptance Criteria	Comments
Other Resources	Proposed requirements or requirement changes must be consistent with personnel, computational, and other resources. The impact of proposed requirements or requirement changes that are NOT consistent with the necessary resources needed to satisfy the requirement must be evaluated and the results of this evaluation provided to the conveyor of the requirement before acceptance.
Targeted Software	Proposed requirements or requirement changes must be consistent with existing software. If not, approval from all stakeholders will be needed before new software development is done.

Table 2-4. Obtain Commitment to Requirements

Method	Comments
Email	As described in Table 2-1, email is sent to the requirement conveyor to confirm the receipt of the requirement. In addition to confirming the receipt of the requirement, where appropriate, this or a different email may be sent to the requirement provider explaining our understanding and interpretation of the requirement Table 2-2. The near-term and long-term implementation strategy for the requirement is also described especially any impact to other efforts.
SCCR	A CERES SCCR is opened by the appropriate CERES subsystem lead when a new requirement is received by the software development team. SCCRs are emailed to the entire CERES DMT and to the appropriate Science Team WG. The SCCR is discussed at a biweekly meeting of the CCB (Reference 9) during the DMT meeting. The CCB chair approves or disapproves the SCCR. If necessary at the end of software development activity and before the resulting modified or new software is delivered to CM, the SCCR is updated to reflect in more detail the nature of the science changes, non-science changes, and parameter changes that actually resulted from implementing the accepted requirements.
Software	The completed software can be obtained by the members of the WG.
Test Results	The result from CM testing following the subsystem's specific Test Plan is recorded in the TRL.

Table 2-5. Response to Provider (1 of 2)

Documents	Comments
Email	Email is sent to the requirement provider to confirm receipt of the requirement, to verify the interpretation and understanding of the requirement, and to describe the near-term and long-term implementation strategy for the requirement.

Table 2-5. Response to Provider (2 of 2)

Documents	Comments
SCCR	Typically, the requirement provider is on a distribution list that will receive an email message containing the complete SCCR when the pertinent SCCR is submitted. An Email is sent for subsequent updates to the SCCR. This keeps all parties advised of the implementation status of the requirement. Those who may not receive an email notice from the CM SCCR system may always view the SCCR through the CERES CM Web site.
Requirements Log	All stakeholders in this process area have access to the CERES Requirements Log Web site. Requirement providers should be able to confirm when the requirement they provided was received and accepted.

Table 2-6. Maintain Bidirectional Traceability of Requirements

Documents	Comments
Requirements Log	The major requirement is identified in the subsystems Requirements Log with the subsystem and single number. Sub-requirements that are derived from the major requirement are indicated with a decimal and number from the major requirement.
SCCR	The SCCR will contain the requirement number for each change that is implemented. The SCCR will list addition, deletions, or changes of parameters.
Biweekly DMT Meeting Status Reports	Updates provided to the DMT that are tied to requirements will have the requirement number listed.
Prologues	The prologue in each module, function, or subroutine will identify the SCCR in the description of the change.
Program Plan	CERES is in the maintenance phase so most modification do not require much time. The Program Plan provides system-level guidance and resource allocation.

Table 2-7. Identify Inconsistencies between Requirements (1 of 2)

Methods	Comments
DMT Meeting	During the biweekly DMT meeting, the production priority, delivery schedule, work tasks, and SCCRs are discussed. The DMT meeting is attended by representatives from the CERES DMT Lead, task managment, each subsystem team, CM team, and ASDC.
SCCR	The SCCR is discussed during biweekly DMT meetings. This forum will allow questions and discussion about impact to other subsystem, delivery schedule, and impact on other tasks. The Science WG Chairs can review the information in a SCCR through an auto generated email they receive.

Table 2-7. Identify Inconsistencies between Requirements (2 of 2)

Methods	Comments
Science Team Meetings (formal and informal)	Science WG Chairs hold meetings that include attendance of DMT members to determine changes in the CERES data products and any impacts on downstream subsystems.
Pre-DMTM Meetings	Members of the subsystems meet biweekly to discuss schedule, resource impacts, risks, and progress on implementing requirements.
Science Testing	The Science WG Chairs need tor approve CERES data products before the software can be delivered.
CM Testing	CM maintains the TRLs that record problems that occur during CM testing.

The contract Program Manager reviews the monthly report which includes information on Requirements Management. The CM section provides a count on the number of Requirements Logs that were updated during the month. Subsystems will report progress on implementing requirements in their section. Finally, if any problems exist with requirements, they would be recorded in the Problem section. CERES Supervisors have regular meetings with the Program Manager to discuss progress and issues with the CERES DMT.

3.0 Requirements Logs

CERES software requirements, at least in general, are provided to specific CERES subsystem teams. A list of the CERES subsystems grouping for requirement purposes follows.:
1. Instrument (Subsystem 1)
2. ERBE-like (Subsystems 2 and 3)
3. Clouds (Subsystems 4.1 through 4.4)
4. Inversion (Subsystem 4.5 and 4.6)
5. Instantaneous and Synoptic SARB (Subsystem 5 and 7.2)
6. Synoptic SARB (Subsystem 7.2)
7. TISA and Grid Averaging (Subsystem 6, 7, 8, 9 and 10)
8. GGEO (Subsystem 11)
9. MOA (Subsystem 12)

Requirements Logs are maintained by each CERES subsystem and contain the fields listed in the following table.

Table 3-1. Fields in a CERES Requirements Log

Field Number	Field Description
1	Requirement Number
2	Requirement
3	SCCR
4	Provider
5	Responsible Subsystem
6	Responsible Person
7	How was the new requirement conveyed to the subsystem team
8	When was the new requirement received by the subsystem team
9	When was the new requirement accepted by the subsystem team
10	When was the requirement completed
11	The current status of the requirement

The procedure for updating a subsystem requirements log follows.

CERES Subsystem Lead
1. Retrieve the current version of the document from the CERES Requirements Log Web site (see Reference 7).

2. Make modifications to the document. A new requirement will also require a SCCR to be open. Subsequent sub-requirements are entered into the requirements' log under their "parent" requirement. Status of open requirements should be updated.
3. Email the document to the CERES Documentation Team.

CERES Documentation Team
1. Version control - confirm the baseline of the modified document is as expected
2. Review the document and ensure compliance with standards
3. Update the version number
4. Create PDF version
5. Post a copy of the revised Requirements Log on the CERES Requirements Log Web site
6. Store a copy of the document into the CERES documentation repository
7. Replace the CERES Requirements Log Web link to the updated document

On a biweekly basis a request for input to the biweekly Data Management Team Meeting Status Report is sent to all subsystem team members. A reminder to update subsystem requirements logs is included with this request. Also, on a biweekly basis, the status of ongoing activities in support of recorded subsystem requirements is provided in the DMTM status report.

References

1. NOW 1.32 CERES and ERBE Data Management System Support, Program Plan.

2. CERES Algorithm Theoretical Basis Documents, http://asd-www.larc.nasa.gov/ATBD/

3. CERES Software Requirement Documents, http://asd-www.larc.nasa.gov/SRD/SRD.html

4. CERES Science Team Meeting Minutes, http://asd-www.larc.nasa.gov/ceres/STM/CERES.STM.html

5. CERES Science Team Meeting II Minutes, http://asd-www.larc.nasa.gov/ceres/STM/CERES-II.html

6. CERES DMT Meeting Minutes, http://asd-www.larc.nasa.gov/dms/dmtm.html

7. CERES Requirements Log Web site, http://asd-www.larc.nasa.gov/ceres/requirements_logs/

8. CERES CM Web site, http://earth-www.larc.nasa.gov/~cerescm/

9. CERES DMS Configuration Management Plan,

Appendix A
Abbreviations and Acronyms

ASDC	Atmospheric Sciences Data Center
ATBD	Algorithm Theoretical Basis Document
CCB	Configuration Control Board
CERES	Clouds and the Earth's Radiant Energy System
CM	Configuration Management
DM	Data Management
DMP	Data Management Plan
DMS	Data Management System
DMT	Data Management Team
DMTM	Data Management Team Meeting
DP	Data Processing
EOS	Earth Observing System
ERBE	Earth Radiation Budget Experiment
ERBS	Earth Radiation Budget Satellite
GGEO	Gridded Geostationary Narrowband Radiances
LaRC	Langley Research Center
LaTIS	Langley TRMM and Terra Information System
MOA	Meteorological, Ozone, and Aerosol
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
PDF	Portable Document Format
PGE	Product Generation Executable
SARB	Surface and Atmospheric Radiaiton Budget
SCCR	Software Configuration Change Request
SDP	Software Development Plan
SOW	Statement of Work
TISA	Time Interpolation Space Averaging
TRL	Test Result Log
TRMM	Tropical Rainfall Measuring Mission
WG	Working Group